# DIE CASTING ENGINEER

June, 1958

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- **DEVELOPING THE ONE-PIECE CAST STEEL FRAME**
  The thought process behind this concept is described.
  Page 8.

- **STEELS FOR ALUMINUM DIE CASTING DIES**
  A complete and up-to-date appraisal of the important alloys going into die casting dies for aluminum.

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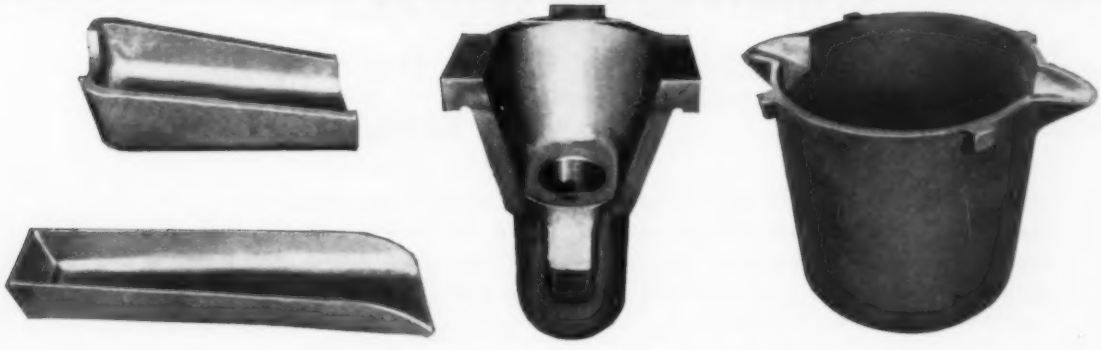

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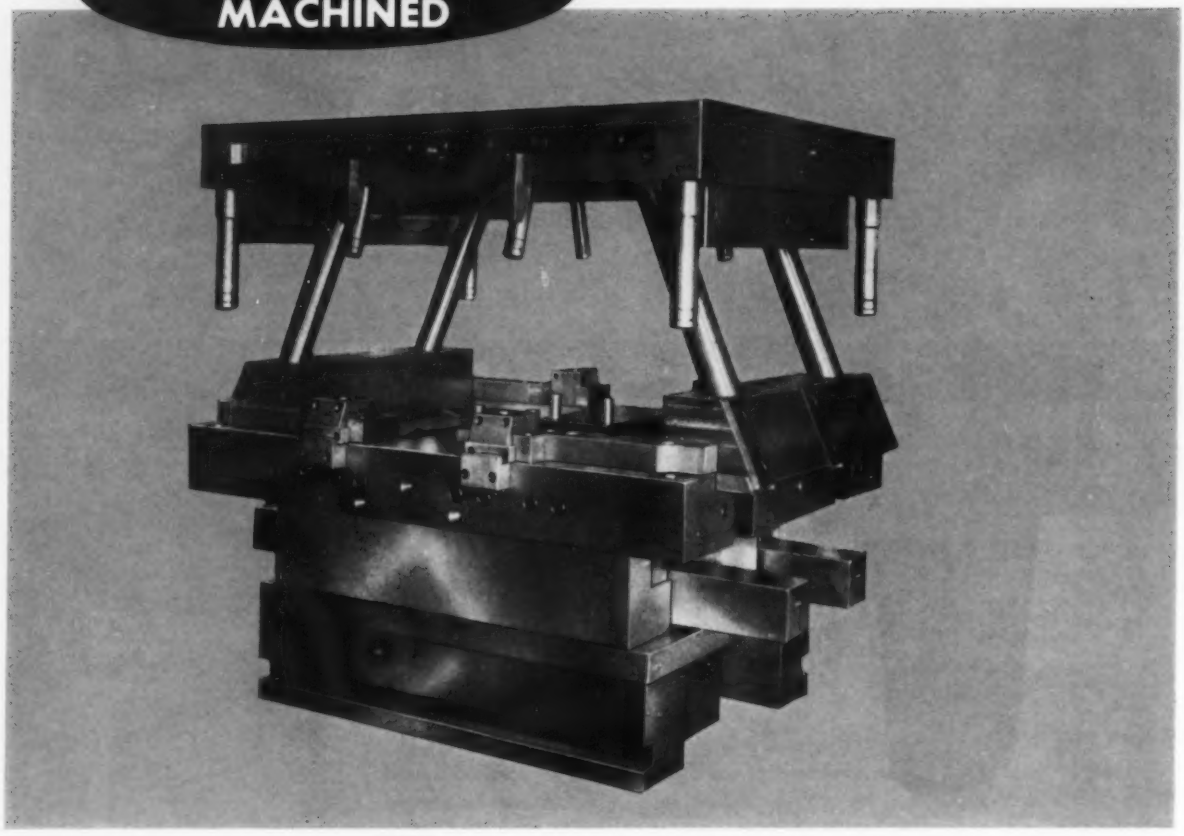

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VOLUME 2
NUMBER 2
JUNE, 1958

# DIE CASTING ENGINEER

Official Publication of
THE SOCIETY OF DIE CASTING ENGINEERS, INC.

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### COVER

A Lester Engineering one-piece cast steel frame die casting machine being tested for clamping tonnage by the proposed SDCE Referee Method of test for clamping capacity.

The DIE CASTING ENGINEER is published quarterly by The Society of Die Casting Engineers, Inc.—a society for the improvement and dissemination of the knowledge of the arts and sciences of die casting, the finishing of metals, and the allied arts. The DIE CASTING ENGINEER offers a concentrated coverage of management and engineering in the die casting and directly related industries.

Only advertising pertaining to die casting and finishing of metals and the allied arts is acceptable. The Society reserves the right to reject any advertising deemed objectionable for any reason what-so-ever.

Subscription rates are as follows: SDCE members—included in membership dues; Non-members—$6.50 per year; Single copies—$1.75; Foreign countries—$8.00 per year.

The Society of Die Casting Engineers and its editorial staff do not necessarily endorse signed articles or statements appearing in the DIE CASTING ENGINEER.

Printer: Ann Arbor Press, Inc., 317 Maynard Street, Ann Arbor, Michigan.

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*to die cast aluminum motor end-bells . . .*

**ABOVE:** Operator removing end-bell casting from one of Emerson-Electric's new Model 400-N Clevelands. End-bell is 6¼" in dia. Weight of shot approx. 2½ lbs. A close-up view of the "as-cast" part is also shown.

**BELOW:** Cleveland Model 400-N with aluminum shot end. Also available as a hot chamber, zinc machine. Has 36"x40" die plates; 400-tons locking pressure, **strain gage tested.**

## EMERSON-ELECTRIC AGAIN SELECTS MODEL 400-N

# CLEVELANDS

The Emerson Electric Mfg. Co., manufacturer of Emerson-Electric motors and appliances, operates two Model 400-N Clevelands in their St. Louis plant, to cast aluminum motor end-bells.

Based on the excellent performance of these Clevelands, Emerson-Electric has recently installed *two more* Model 400-N Clevelands in their new, modern plant at Paragould, Ark. These new Clevelands are also producing aluminum end-bells in two-cavity dies.

For the Paragould installation, the new Model 400-N's were built as "right-hand" and "left-hand" machines; are located shot end-to-shot end. One operator controls both machines, ladling from a central furnace.

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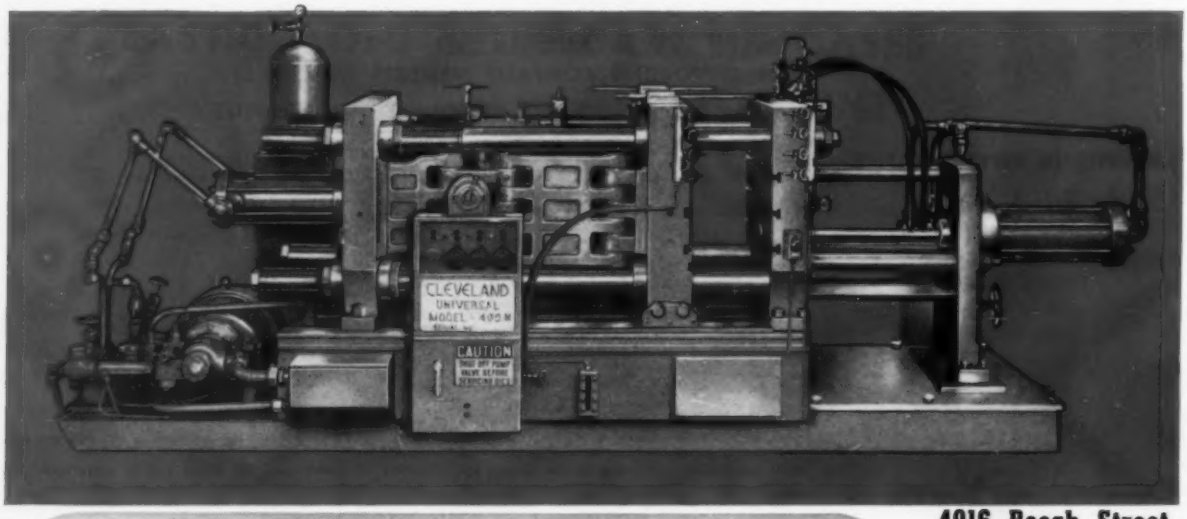


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Thank you in advance,

I. A. Lunacharskaya, Head
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**This letter received last April is indeed more than a mere specimen copy request. The Institute of Scientific Information houses the world's greatest abstracting system ever devised. From among the tens of thousands of publications the world over, the *Die Casting Engineer* has even been chosen for translation and abstraction, indicating the thoroughness of the USSR in its efforts to gain technological, and possibly world, supremacy. The United States is in the process of setting up a similar governmental agency.—Ed.**

## COMMENTS ON THE SUBJECT OF VACUUM DIE CASTING

Dear Sir:

I read with interest the article appearing in this month's issue of the *Die Casting Engineer* with respect to vacuum die casting equipment. I feel very strongly that this article was made with insufficient preparation, and is full of inaccuracies . . .

I have sent you . . . an article which goes into this subject quite thoroughly and proves by means of physical law that . . . the evacuation of dies reduces the injection pressure necessary. If you reduce the injection pressure necessary, you, by necessity can decrease the size of the machine; or, conversely, increase the projected area which can be cast with the same injection pressure . . .

I want to bring to your attention the mere fact that the die faces are apart and we purge our vacuum through a massive valve with an explosive action giving us much greater efficiency in removing air at lower vacuums than the other systems using higher vacuums operating to 0.006 clearance points into the die cavity itself. You must use high vacuums when you are restricting the passage of air through overflows, vents, etc., because, at the low air pressures involved, air friction becomes a very serious problem which all other systems introduce. Our system of keeping the die faces apart, sweeping the rush of air across the die faces, effectively purges any latent air which would be trapped in thin wall sections

*(Concluded on page 17)*

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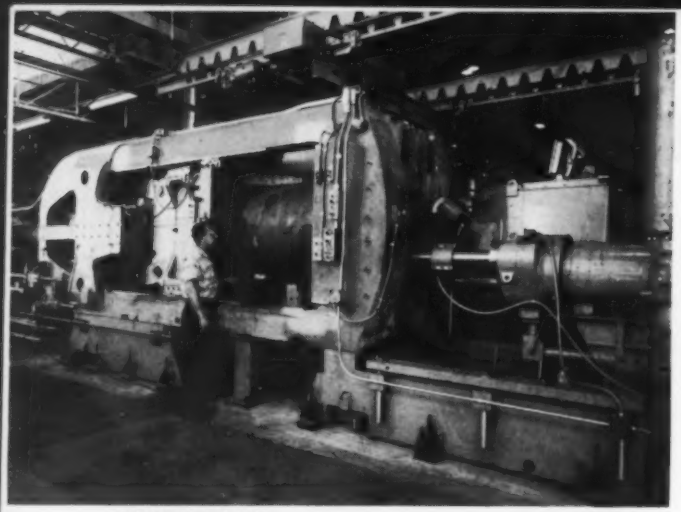


COVER STORY

FIGURE 1

**ADVANTAGES OF THE ONE-PIECE CAST STEEL FRAME**

- **Full rated clamping tonnage over long periods without failure or undue wear.**
- **Extra high effective clamping tonnage to prevent flashing and die wear.**
- **Absolute minimum risk from human error in die set-up.**
- **Unobstructed die space without any sacrifice in locking tonnage.**
- **Permanent accuracy in die alignment during opening, closing, and locking over long periods of years without failure or undue wear.**

## Lester Engineering describes the thought process behind . . .

# Developing The One-Piece Cast Steel Frame

***DAVID J. SLOANE,*** *Vice President, Lester Engineering Company*

IN THE EARLY TWENTIES all die casting machines were built with two end plates joined by four tie bars. In most designs the platens rode on the bars and the end plates were bolted to the machine base. Within the limits that time, money, ingenuity, and personnel allowed, these early designs were changed and refined in response to the need for new die casting techniques. New materials and controls were added, but the basic tie bar design was retained.

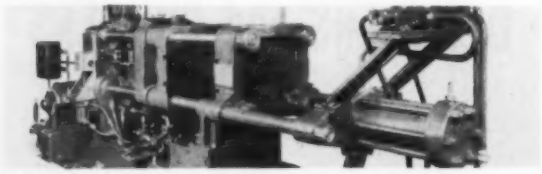


***FIGURE 2: A 1937 Lester machine of tie bar design.***

With all of these designs there was a history of pin breakage. Links twisted out of shape. The bars moved and weaved under load. But no machine manufacturer had anything better to offer and every die caster lived with the situation because there was no alternative available.

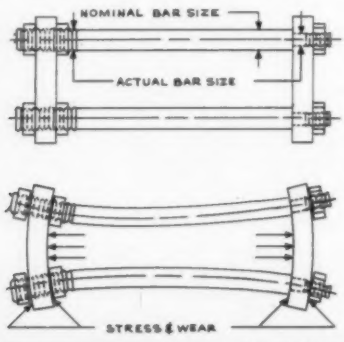



***FIGURE 3: Forces, stresses, and wear points inherent in the tie bar cage design. The indicated strain is greatly exaggerated.***

It was found that in new machines operating with moderate locking loads, pin breakage was no problem. Low shot pressures caused no particular troubles. It was only as the machines aged and wore themselves out of line and as higher shot pressures and locking pressures became necessary that maintenance became unreasonable. The machine engineers felt that these failures stemmed from a gradual working of the four bars and two end plates-causing uneven loading of the tie bars. This resulted in a twisting of the hardened pins. In trying to design around the problem they were constantly confronted with the fact that a tie bar cage is such an unreliable and unstable structure that any designs based on the tie bar cage as the main structure were doomed to these basic shortcomings.

To further complicate the situation, larger parts and the Cold Chamber Process were introduced. The inability of the available die casting machines to hold the dies shut and the even greater maintenance problem created a condition which could not be ignored. A positive answer, possibly a whole new concept in machine design, needed to be found.

The problem was attacked by analyzing the very purpose of the die casting machine. First to be studied was the concept of "pre-loading." It unveiled the origin of the extreme forces that punish a die casting machine.

In the early development of the die casting machine the common conception among die casters was that in locking the machine they were "taking up the play" in all the components so that the shot could be made against a firm structure. However, the true purpose of the die casting machine is to "pre-load" the die, that is, exert a force to hold the die faces together before any metal is cast. This force must, of necessity, be greater than the force exerted by the liquid metal which tries to open the die. This concept can best be pictured by visualizing a horizontal die with a 600 Ton weight sitting on it. A block of steel weighing 600 Tons would measure 16′ x 16′ x 11′. With the weight sitting on it the die is pre-loaded to 600 Tons. Before the die will lift or move in any way whatsoever, the separating force inside the

die has to equal and then surpass 600 Tons. Such a separating force could be produced with a set of hydraulic jacks. In our process the separating force is generated by the impact of hot metal under high pressure acting over a large projected area.

***Until the pre-load of 600 Tons is surpassed there is no movement of the die and there couldn't be any flashing from overloading.***

This concept is based upon the assumption that the force is evenly distributed over the entire surface of the die. If it were concentrated at a point in the center or at the edge of the die, a different condition would exist where the die is free to deflect and flash even though the total force applied is adequate to prevent flash.

The function of the die casting machine is to create this same condition of preload, rapidly and often, without the use of a cumbersome weight. Steel, rigid as it is, obeys Hooke's Law and is elastic under large loads. The steel frame of the machine and the steel die do not present immovable structures but may be squeezed and stretched in a linear relation with the force applied to them. The frame and the die are simultaneously pre-loaded by the leverage action and mechanical advantage of the toggles. The die is pre-loaded in compression by the locking action of the toggles just as though the weight were being placed on it. At the same time the frame is pre-loaded in *tension* by the locking action of the toggles. In this condition the frame is substituting for the force of gravity in the original example. In other words the bars are stretched like a test bar, well within their safe limit, to build up a pre-load force against the die similar to the one created by the weight in the earlier example.

The amount of flashing that occurs is a function of the accuracy of the shut-off in the die parting line, the rigidity of the die and its ability to take pre-loading, the cleanliness of the parting line when the machine locks, the accuracy of platen alignment for even pre-loading of the shutoff area, and the amount of pre-load developed by the die casting machine, measured in clamping tonnage. The die casting machine can only be responsible for platen alignment and pre-load.

A die casting machine frame arrangement made up of tie bars and end plates, especially where the tie bars may be loosened, removed, and tightened at will, was an extremely poor and unpredictable structure in the light of the "pre-load" concept. Since the end plates and platens, under the force of a pre-load would tend to line up parallel, any misadjustment in the tie bars would result in very uneven tensile loading of the tie bars.

A permanent, dependable structure that could be expected to stay put for the life of the machine was needed. A solid frame, if it could be produced, seemed to be the answer. It would definitely eliminate the movement between the plates and the bars, the severe notches introduced in the bar by the shoulder and threads, and the complex stress concentrations resulting from the bowing of the end plates, the stretching of the tie bars, and the sliding of the end nut in contact with the end plate. It would certainly eliminate uneven loading of the tie bars in die height adjustments, the uneven wear of the tie bars from platen movement, and the possibility of variations in heat treatment between the separate bars. The engineers reasoned that the one-piece solid frame was a positive basis upon which to develop the clamp. They envisioned higher shot impact pressures and higher clamping capacities. The one-piece solid cast steel frame was chosen as the most likely design to achieve these ends economically.

It was quickly recognized that larger beam sections could be designed in shapes ***other than round*** to give ample section for maintaining high locking tonnage with a minimum obstruction to the supported area for die mounting. The link pins could be loaded more nearly in straight shear without introducing complex twisting and bending stresses. The freedom of steel casting design for pre-loading offered the promise of very high locking tonnage over long periods without failure or undue wear.

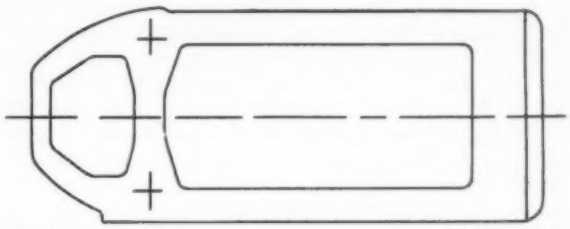


***FIGURE 4: Basic diagram of the one-piece die casting machine frame.***

The first one-piece frames produced were placed under careful scrutiny for stress concentrations. First, the areas of maximum stress concentration were located by means of Stress-coat. In this procedure, the bare casting was polished and then painted with a stress sensitive lacquer. After the lacquer had dried, the pattern of its crazing under load identified the points of maximum stress. Strain gages placed on the frame casting at these stress points allowed the magnitude of the stress to be measured. With acrylic plastic models it was then possible to study the contours and sections in photoelasticity tests in order to alter the designs and reduce all of the extremely high stress concentrations.

Important ideas were generated as the design of the frame developed. The permanent nature of the cast frame and its freedom from loosening or slipping between individ-

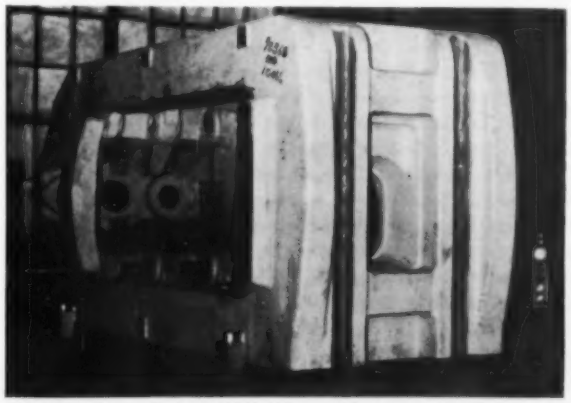


***FIGURE 5: A small one-piece cast steel frame in the process of being finished.***

***FIGURE 6: Hand finishing of the frame and stationary platen to within 0.002" of being parallel to the movable platen and the centerline plane of the main link pins.***

ual parts made it practical to achieve a high degree of precision in the tolerances of the frame dimensions. Since the frame alignment could not be changed over its entire life by either adjustment or wear, the engineers asked for tolerances which were not otherwise practical. These frames were hand finished to a degree of parallelism more accurate than that found in most dies. This close control had a definite bearing on the *effective* clamping tonnage available.

Once the frame was made to such a fine degree of precision, it was no more expensive or difficult to carry this same accuracy into the movable die plate carriage and construction. In fact, it would have been a foolish waste of money to finish the frame to a high degree of precision and then combine it with a locking mechanism, whether crudely or accurately made, that would have allowed excessive wear in a short time. The nature of the cast frame was a clear invitation to the designer to insert hardened ways into the four beams so that the platens could be supported and guided on *flat* bearing areas with movement being in a level and straight line. These same hardened ways could often be used as bearing surfaces for heavy overhanging dies. The platens were equipped with replaceable shoes where they rode on the flat ways. A second system was also used where the movable platen rode on hardened ways below the frame on the base of the machine, having support and guidance on the bottom of the platen only. The hardened ways, in contrast to the softer tie bars, resisted wear and galling from the abrasion of metal grit, dirt, and miscellaneous solids that are present around a die casting machine.

***(See Figure 1, Page 8)***

As time passed and the frames were more widely used and accepted, new steel alloys were made available by the foundries as well as new heat treatment and foundry casting techniques to improve the quality and metallurgical structure of the castings. Stress relief, heat treatment, and magnafluxing became routine procedures. With these tools significant improvements were constantly being made to enhance the value of the frames in this die casting machine application. Had the tie bar type of frame been retained, the latitude in this type of refinement would have been impossible.

With the accuracy of the cast steel one piece frame the question of even loading of the beams and shut-off area in the die was to a large extent taken out of the hands of the set-up man. So long as the die was parallel within normal tolerances and centrally positioned in the machine, there was even pre-load in each beam without any attention from the operating personnel. This quality in the frame machine was not contributed by the frame alone, but was also a function of the design and workmanship in the toggle system and movable die plate assembly.

The central die height adjusting screw, for which a patent had been issued some time before work was begun on the solid frame, was incorporated into the new one-piece steel frame. It was a single large diameter screw (see Figure 6), installed in the center line of the machine, to take the place of the four threaded adjustments on the tie bar type of frame. This large screw was placed immediately behind the movable die plate. The screw was threaded into a large auxiliary platen called the "adjusting die plate" to differentiate it from the movable die plate. The two die plates and the large screw as an assembly were used in place of the conventional movable die plate. The front plate had the die mounting holes or T-slots. The rear plate attached to the toggle links. Between the two was the adjusting screw. This assembly moved back and forth similar to a die plate. Its advantage came from the fact that the adjusting screw could be turned by a single adjustment to alter the die height of the machine. This adjustment was made by either a hand crank or an electric drive, so that die height could be altered quickly and accurately, either in setting up or in adjusting for thermal expansion in the die. The adjustment was accurate because the human element involved in adjusting four bars had been eliminated.

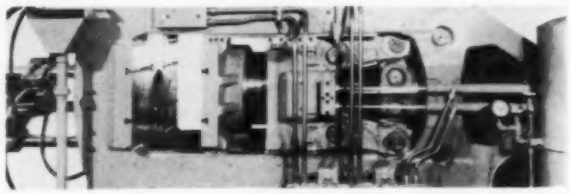


***FIGURE 7: The central die height adjusting screw is located between the movable die plate and the adjusting die plate. The single hand crank is on the operator's side of the machine.***

With the emphasis that the engineers placed on even pre-loading, the idea of pulling a tie bar to mount the die was frowned upon. The alternatives to pulling a tie bar were numerous. In one large die casting shop running more than ninety of these frame type machines, there have been row on row of machines running dies with three, four, five, and even six hydraulic core pull cylinders extending between the top, bottom, and side openings in the frame. Standard core-pull cylinders, which were mounted and removed as required to allow a die to be mounted or taken out of the machine, were kept on racks in the die casting area. Actual time trials have shown that, over the long run, the advantage in set-up time lies with the unit frame. The routine nature of handling core-pull cylinders was much faster as compared with setting and loosening tie bar nuts which were subject to binding or seizing during adjustment.

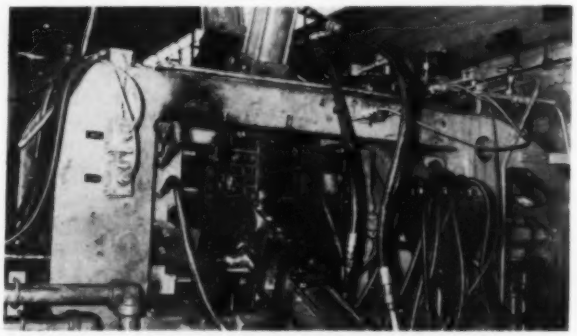


***FIGURE 8: Three core pulls and cylinders are easily set between the beams in the sides and top of this machine.***

Accessories of great help in die mounting were a large U-clamp used to lift and place the die in a single operation and a ball bearing sliding plate for easily moving a die sideways into clamping position prior to clamping and core cylinder mounting. Fork trucks were also commonly used. Without these aids the die was either lowered through the opening in the top of the cast frame or slid through the side of the frame with the help of a chain hoist and sliding plates.

The solid one-piece cast steel frame die casting machine has met with well-deserved success. It is successful because it was founded upon sound engineering for a specific purpose.

■ ■ ■

**Dr. J. C. HAMAKER, Jr.,** *Research Manager, and* **Dr. G. A. ROBERTS,** *Vice President-Technology, Vanadium-Alloys Steel Company*

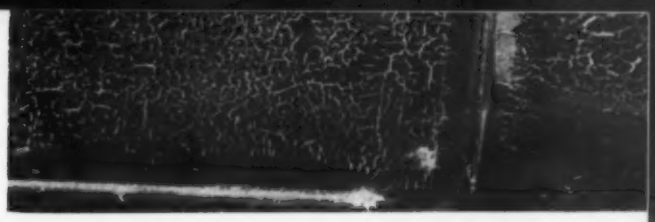


***FIGURE 1: Large heat checks in aluminum die casting die.***

## An appraisal of . . .

# Steels for Aluminum Die Casting Dies

STEELS FOR ALUMINUM DIE CASTING DIES are required to meet very exacting property requirements in order to provide the long service life necessary for economical operation. They must resist heat checking through hundreds of thousands of cycles, involving alternate heating and cooling in which the surface layers approach the temperature of molten aluminum. They must also be sufficiently hard and strong to withstand the erosive action of aluminum and heavy die pressures, yet tough enough to avoid breakage due to water cooling, deep cavities, or accidental misalignment. Finally, from a diemaker's viewpoint, they should be readily machinable, harden in air from a low temperature with minimum movement, resist excessive scaling on air cooling, and be sufficiently low in alloy content for reasonable cost.

To meet these requirements, Vanadium-Alloys Steel Company introduced about 25 years ago, the 5% chromium steel which met with immediate success in field tests and has become the basic type used for aluminum die casting dies.* Since that time, intensive research has been continued on the nature of aluminum die casting die failures, and new compositions and treatments have been tested in an effort to improve die life. The following paragraphs will briefly summarize various aspects of this investigation.

From extensive studies of production dies removed from service after prolonged operation, three principal types of failure have been recognized:

1. Heat checking.
2. Pitting.
3. Impingement soldering.

Gross cracking is another source of failure, generally occurring early in the die life, and related more to improper heat treatment or die design than to the effect of service exposure.

Heat checking is, of course, not confined solely to die casting dies, but is found in all hot work tools involved in forging, extrusions, upsetting, or similar operations. However, the heat checks in die casting dies are more readily detected because the light aluminum imbedded in them contrasts with the oxidized steel, as shown in Figure 1. Heat checks of this magnitude were obtained on a core 6" diameter by 30" long which produced over 350,000 castings at 56 per hour. A 7⅜" length of this core was in contact with molten aluminum at 1170° F., with the average center temperature of the die at 450-500° F. This core also contained some pitting in areas where the heat checking was not too severe.

***From microscopic examination of many dies in various stages of service life, and analysis of die casting conditions, the following steps appear to lead to the formation of pits and heat checks.***

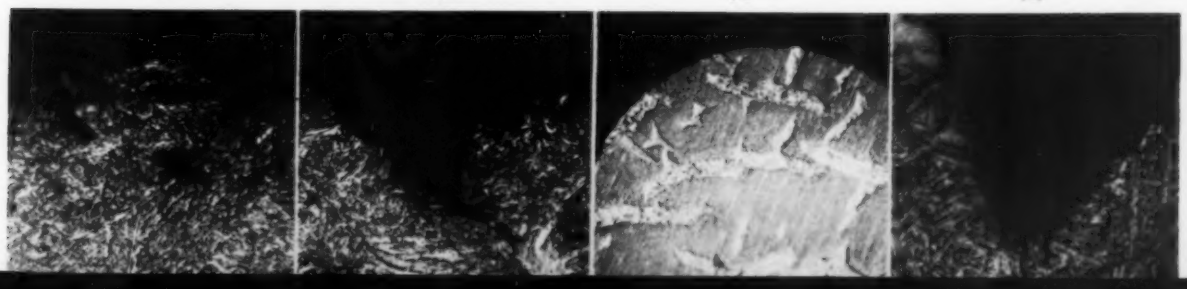
First, minute cracks, frequently less than .001" long, form along the grain boundaries of the steel at the surface of the die. Figure 2 shows a grain nearly broken out of the steel surface by tiny cracks along its grain boundaries. These cracks are believed to form by a combination of fatigue stresses and oxidation. Fatigue stresses in the steel arise from both the casting pressures and by thermal gradients. Figure 3 shows temperature readings obtained over very brief time intervals from thermocouples inserted in the surface of an operating die and also in the die interior. Temperature readings like those shown for the die interior are obtained at locations only 1/16" to ¼" below the die surface. Thus, during each casting shot, the die surface is heated in a fraction of a second from the die temperature of 500-600° F. to temperatures approaching molten aluminum, whereas the bulk of the die immediately under this 1/16"-¼" surface layer remains essentially constant at the die operating temperature. Calculating from the elevated temperature properties of the steel, we find that a temperature gradient of this magnitude produces thermal stresses well over 100,000 psi. Adding to this the casting pressure of the machine, stresses approaching the 130,000 psi fatigue endurance limit of the steel can be readily visualized. Oxidation by the air then accelerates the fatigue tendency to produce grain boundary cracking by a mechanism similar to stress corrosion in other metals.

After a grain has cracked out of the surface (Figure 2b), we have pitting, which is essentially an initial stage of heat checking. The bottom of the pit is a natural stress raiser to

* *U. S. Patent No. 1,938,221, issued to J. P. Gill, Dec. 5, 1933. Trade name Hotform.*

***FIGURE 2: Stages in the formation of a heat check. (a) A microscopic cross-section showing initial stage of heat checking in which steel grain is almost completely separated from matrix by cracking along grain boundaries. 2% Nital etch, 500X. (b) Grain broken from matrix, leaving pit. 2% Nital etch, 500X. (c) Surface of typical heat checks, containing aluminum, formed by progressive growth of pit across valley until adjacent pit is encountered. Unetched, 14X. (d) Cross-section of typical heat check showing stress cracks at bottom. 2% Nital etch, 500X.***

***(a)*** ***(b)*** ***(c)*** ***(d)***



initiate a new crack under the continued mechanical and thermal stresses. The pit thus progressively grows not only in depth but also laterally along the die surface until it encounters an adjacent pit. The resulting valleys between pits constitute "heat checks," which are shown on the surface of the core at 14X magnification in Figure 2c. The cross sections of the heat checks themselves (Figure 2d) frequently have stress cracks at the bottom, indicating the progressive nature of this deterioration once it begins.

Another type of pitting, not associated with heat checking, may occur if the die is improperly protected between heat treatment and installation in service. This pitting arises from rust spots which provide openings in the protective oxide layer and grow progressively as the die is alternately cooled in air. Pits of this type are generally shallow, with no evidence of the grain boundary or bottom cracking usually associated with thermal fatigue stresses.

The third type of failure, impingement soldering, is shown on the side of a core insert die in Figure 4. Cross sections through this soldered area revealed small particles of aluminum mechanically held in pits formed by one of the methods described above. After a small amount of aluminum is imbedded in a pit, crack, or scratch, it appears to build up rapidly and form a visible deposit on the die surface.

***Throughout the investigation of numerous dies, there was no evidence of aluminum attacking, alloying with, or dissolving the die steel. Any aluminum attached to the die was mechanically held, with scale or an air gap between it and the die steel.***

Furthermore, no changes whatsoever could be detected in the heat treated structure or the hardness of the steel, even in dies subjected to the most severe operating conditions. Microhardness tests showed no significant variation from surface to center of the die, and the typical photomicrographs clearly show that the die steel has retained its initial heat treated structure to the very surface of the die, as well as on the surfaces of heat checks or pits. Thus, the principal defects in aluminum die casting appear to arise from mechanical fatigue stresses and grain boundary oxidation in the air, rather than from any reaction between the molten aluminum and the die steel.

Based on the above analysis, and many additional studies of die performance versus steel properties, the major requirements for aluminum die casting die steels are listed in Table I. Also noted are the steel characteristics which satisfy the various requiments to the maximum extent. Now let us see how present aluminum die casting die steels measure up to these requirements.

In Table II are listed the four current hot work die steel compositions that evolved from the 5% chromium steel initially introduced in 1933. The principal types H-11, H-12, and H-13 have very similar properties and show no clear-cut differences in performance. Research studies conducted in 1946 indicated an improvement in hot hardness by adding .50% vanadium to H-11 and H-12 and a slight further improvement at higher temperatures by adding 1% vanadium to H-13. However, the performance difference between H-12 and H-13 is not apparent—perhaps because the hot hardness increase is only evident at temperatures above which the dies actually operate. The tungsten bearing grades H-12 and H-14 are said to be more susceptible to cracking from sudden temperature changes, so water cooling should be used continuously. However, H-12 with 1.5% tungsten has been used with success for the application, so the susceptibility must require somewhat more tungsten to make itself seriously felt. For the following discussion, the H-11 type with .50% vanadium will be selected as representative of the group.

The first requirement for aluminum die casting die steels

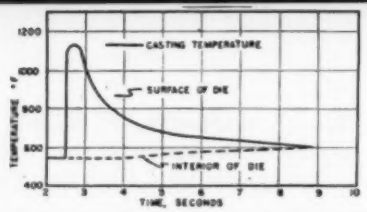



***FIGURE 3: Temperature changes observed by inserting thermocouple in surface and interior of die casting die during operation. (Mickel)***

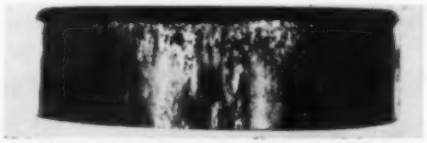


***FIGURE 4: Side view of core insert die showing impingement soldering.***

***FIGURE 5: Aluminum imbedded in heat check, separated from steel by scale. 2% Nital etch, 500X.***

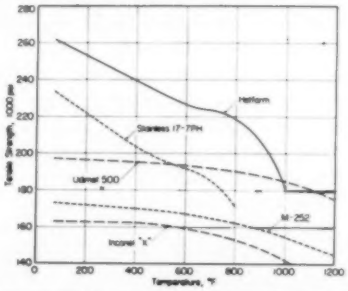



***FIGURE 6: Hot strength of H-11 compared with various high strength and super alloys.***

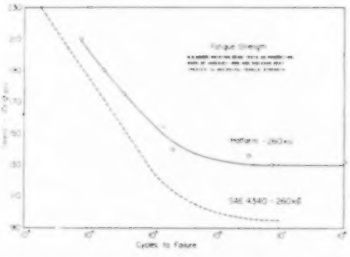


***FIGURE 7: Fatigue strength of H-11 compared with that of low alloy high strength steel SAE 4340 at the same hardness level.***

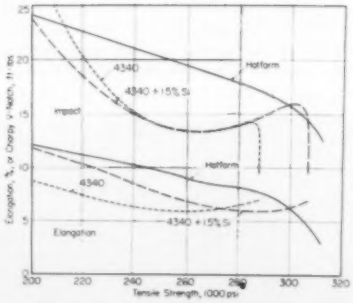



***FIGURE 8: Toughness and ductility of H-11 compared with SAE 4340 at the same hardness level.***

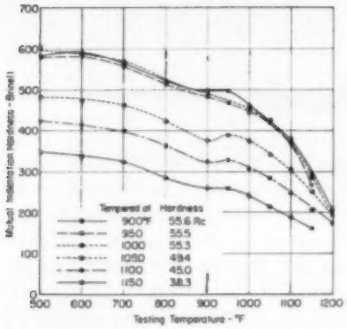



***FIGURE 9: Hot hardness of H-11 at various test temperatures.***

**Table I**
**REQUIREMENTS FOR ALUMINUM DIE CASTING DIE STEELS**

RESISTANCE TO THERMAL FATIGUE:
Hot Strength; High Fatigue Strength
0.25—0.50% C; 40-50 Rc.
OXIDATION RESISTANCE:
Cr and Si Additions
TOUGHNESS AND RESISTANCE TO THERMAL SHOCK:
Low C, W, and Mo; High Tempering Temperature
RESISTANCE TO BRINELLING AND WEAR:
Hot Hardness; Alloy Carbides from W, V, or Mo.
MINIMUM DISTORTION IN HARDENING:
Deep Hardenability for Air Hardening
MACHINABILITY:
Low Annealed Hardness; FM Additions
LOW COEFFICIENT OF EXPANSION AND HIGH THERMAL CONDUCTIVITY:
Quite Constant for Hardenable Steels
LOW COST:
Minimum of Expensive Alloys

**Table II**
**COMPOSITIONS OF PRINCIPAL HOT WORK DIE STEELS FOR ALUMINUM DIE CASTING DIES**

| | H-11 | H-12 | H-13 | H-14 |
|---|---|---|---|---|
| Carbon | 0.35 | 0.35 | 0.35 | 0.40 |
| Chromium | 5.00 | 5.00 | 5.00 | 5.00 |
| Tungsten | — | 1.50 | — | 5.00 |
| Molybdenum | 1.50 | 1.50 | 1.50 | — |
| Vanadium | — | 0.50★ | 1.00 | — |

**Table III**
**PRECAUTIONS FOR MAXIMUM DIE LIFE**

1. Surface should be free of scratches, stamp marks or other stress raisers.
2. Avoid decarburization in heat treatment; slight carburization may be helpful.
3. Circulate air during quenching of heavy dies to avoid intermediate structures having inferior properties.
4. Double or triple temper at the proper temperature for the desired hardness.
5. Provide a tight, adherent oxide film by proper "break-in" period. Avoid rusting or scratching through this film.

***FIGURE 10: A 26,000 pound liner for extrusion press made from H-11 hot work die steel.***

(Table I) is resistance to thermal fatigue, as provided by high hot strength and fatigue strength. In the temperature range of interest to die casting, up to 1000° F., the hot strength of the H-11 type exceeds that of all other materials, including the highly alloyed super alloys developed for jet engines (Figure 6). The fatigue strength of this steel is also outstanding, surpassing by 20 to 35% that of the low alloy steel AISI 4340, which has been extensively used in fatigue applications such as gun and aircraft parts (Figure 7).

The toughness requirement has also been very satisfactorily met, providing 30-40% higher impact strength than the common high strength steel 4340 at the same hardness and strength levels (Figure 8). Resistance to Brinelling and wear is provided by hot hardness that is excellent for a material of this toughness (Figure 9).

Other requirements are also quite effectively built into the steel. The 5% chromium content provides moderately good oxidation resistance, and when combined with the molybdenum content, results in one of the most deeply air hardening steels, having low movement characteristics. The 26,000 pound liner for a hot extrusion press, shown in Figure 10, provides an illustration of its hardening capacity. The high tempering temperature results in maximum stability during long elevated temperature exposure and, combined with a low coefficient of expansion, insures good thermal shock resistance.

From this brief survey of its properties, it appears that the 5% chromium hot work die steel has a rather outstanding array of properties for aluminum die casting die requirements. From these data, it is understandable why the 5% chromium steel has continued to give the most adequate performance in aluminum die casting dies in the face of the many new tool steel compositions that have been tested for this purpose.

Continuing research is, of course, going on in a search for better die steels and better die life. Higher silicon and chromium contents in the steel are being field tested in an effort to obtain improved oxidation resistance and reduce the tendency for heat checking from that source. Extensive mechanical testing is being conducted on new steel compositions in a search for better hot strength, fatigue strength, toughness, and hot hardness.

Surface treatment and modification of existing steels have also shown promise. The 5% chromium steels nitride as readily as the nitralloys with much better core strength and hardness. The nitrided surface appears to provide better life in die parts having severe service conditions. Higher heat treated hardness may improve resistance to heat checking in simple die designs where danger of cracking is not prevalent.

***A major difficulty in the development of new die steels is the long waiting period, possibility of lost information, and difficulty in obtaining definitive comparisons in field testing. New machines and equipment are continually being developed and tested in an effort to obtain a laboratory method of producing heat checks and other die failures that would correlate with service experience.***

Heat checking, pitting, and other failures of aluminum die casting dies after prolonged service, appear to be caused by a combination of fatigue stresses, arising both from alternate heating and cooling of the die surfaces and mechanical casting pressures, together with air oxidation of the grain boundaries in the surface of the steel. The five percent chromium steels appeared to offer the best combination of properties presently available for resisting these failures and providing other die casting die steel requirements. Based on research studies, the precautions listed in Table III are offered as suggestions for obtaining maximum die life from the steel.

■ ■ ■

# Chapter News

## 1 DETROIT and 2 SAGINAW VALLEY

April Fools Day found our chapter gathered together at Devon Gables for dinner and a timely talk by Dr. Richard B. Saltonstall, Technical Director of The Udylite Corp., on the subject, "Improvements in Chromium Plate for Zinc Base Die Casting." Besides telling of techniques for improving the protective value of decorative coatings, Dr. Saltonstall related some instances where buffing of the die castings had been completely eliminated. On May 6th, Foster C. Bennett, Assistant Chief of the Development Section of the Metallurgical Laboratories for Dow Chemical Company, presented "Mechanized Magnesium Die Casting in 1958." In dropping down from Midland, "Foss" brought along some slides depicting magnesium die casting activity in Europe—along with interesting scenery and road signs. Dow's new ladling system, described in the December, 1957, issue of this magazine, was also discussed. Our last meeting until fall, on June 3rd, brought out an overwhelming number of die casters to hear Mr. E. L. Morton, owner of the Morton Manufacturing Co., Omaha, Nebraska, narrate his film, "Morton Vacuum System." The film showed zinc and aluminum vacuum die casting in production along with its advantages and his method of adaption for self-ladling. Some very interesting methods of cost cutting were also stated. Our Stag Day Golf Outing at Pontiac Country Club, June 28th, has already attracted well over 100 reservations.

*—Ollie Clayton*

## 3 WESTERN MICHIGAN

Mr. L. H. Hyde, Purchasing Agent for the Machined Parts Department, Ford Division Purchasing Office, Ford Motor Company, highlighted our April 8th meeting at the Schnitzelbank with his talk on, "A Customer Looks at the Die Caster." When a man buys about $25 million of die castings per year, it was no wonder that we were on the edge of our seats to hear everything he had to say. At that meeting I passed along some important facts brought out at the SDCE Board of Directors meeting held March 24th in Detroit. Our May 13th meeting heard Mr. Donald L. LaVelle, Chief of Aluminum Research and Development for the American Smelting & Refining Co., speak on "The Production of Quality Die Castings." The results of our elections that night are: C. M. Stewart, Holland Die Casting Company, Chairman; Merritt Nelson, Grand Rapids Brass Co., Vice-chairman; and R. Uplinger, Grand Rapids Brass Co., Secretary-Treasurer. "The Importance of the Independent Die Casters to the Automotive Industry" was the subject of a talk given by Dr. George H. Found at our June 10th meeting. Dr. Found is the Executive Vice-president and General Manager of Saginaw Bay Industries. June 17th was our big Open House at the B & T Machinery Company Research Center in Holland, Michigan. This was an enlightening experience in some of the newest developments in die casting.—*Carl Neuendorf*

## 4 TOLEDO

After a fine dinner of T-Bone Steak, our members and guests heard Mr. G. L. Werley of the New Jersey Zinc Company talk on the many techniques and problems in "Zinc and Zinc Die Casting." Our May 13th meeting featured a panel discussion on die casting. Gil Taukert, Supreme Impression & Mold, Bud Janke, Die Cast Design Company, and Ollie Clayton, Valor Tool and Machine Co., served on the panel to cover the various phases of die casting. A good crowd turned out at Angelo's Spaghetti House, and we had plenty of excellent discussion. At our June 9th meeting at Angelo's we heard Dr. R. E. Saltonstall of the Udylite Company speak on the, "Electroplating of Die Castings." He brought along some very interesting and informative slides to illustrate the talk.—*Rolland S. Fulton, Jr.*

## 5 CHICAGO

Our April 3rd meeting was the highlight of the year. It was a joint meeting of the SDCE and the Tool and Die Institute, drawing nearly 300 members and guests to see Mr. Irwin Lubalin, General Manager of the Shaw Process Corp., demonstrate "Precision Casting the 5% Chromium Die Steels for the Die Casting Industry." He discussed pattern making, mold making, steel pouring, heat treatment, and finishing of the die cavities. With the help of Mr. Tatterchuck of Atols Tool and Mold Corp., he actually poured a Shaw Process mold. Mr. Lubalin was kept on his toes answering the many questions about this new tool for mold builders. Dr. George H. Found, Executive Vice-president and General Manager of Saginaw Bay Industries, came down to Nielsen's Restaurant to speak on "The Importance of the Independent Die Caster to the Automotive Industry" at our May 1st meeting. A novel approach was used by Mr. James J. Kux, Executive Vice-president and General Manager of Kux Machine Company, at our June 5th meeting. In his talk, "A Three Dimension View of Kux Vacuum Die Casting," Mr. Kux used full color stereo slides, creating the third dimension with 3-D glasses. This chapter's 16-page Membership Directory has been completed and distributed. It proved to be a great financial boost to our treasury. Our "Sport of Scots and Feast for a King" Annual Golf Outing on June 24th at Glendale Country Club promises to be a great time for a large crowd of members and guests.

*—John H. Koller*

## 6 CLEVELAND

Mr. Willard Babbington, Supervisor of the Metals Engineering Group with the Bell Telephone Laboratories, presented an extremely interesting talk on the "Affect of Process Variables on the Quality of Aluminum Alloy Die Castings" at our April 28th meeting. We were also honored to have Mr. Irwin Lubalin at our May 20th meeting to talk on and demonstrate the Shaw Process. In his talk, "Precision Casting H-13 Tool Steel Cavities and Cores by the Shaw Process," Mr. Lubalin also showed a number of samples of different die cavities that are in use in the Industry. A big Clam Bake is planned for September, so watch for announcements this summer.—*Arnold Williams*

## 7 NEW YORK

No word has been received from the New York Chapter about its last three meetings. We understand that the New England Chapter's speaker at its Tuesday evening meeting is usually invited by the New York Chapter to speak at its meeting on Wednesday evening. How about some news and meeting announcements?—*JRZ.*

## 18 NEW ENGLAND

Forty-three members and guests met on March 27th at the Hickory House to hear Mr. Archie L. Spratt, Metallurgical Engineer for Vanadium Alloy Steel Co., talk on die failures. He discussed heat checking, gross cracking, and solder impingement and pointed out the balance between toughness and hardness. He also mentioned some precautions for maximum die life. Our April 24th meeting featured Mr. Donald A. LaVelle, Director of Research and Development on Aluminum for the American Smelting and Refining Co. He fully discussed the "Aluminum Die Casting Alloys" and "Pressure Tightness of Aluminum Die Castings." As a special treat, we held our last meeting before the fall at a historic New England inn, the Publick House in Sturbridge, Mass. This May 22nd meeting featured Mr. Edward J. Pavesic of the Lindberg Steel Treating Co. Mr. Pavesic gave an excellent talk on "Heat Treating of Die Casting Dies and Die Failures." We have had a great year since we were founded, and we look forward to even better meetings and more activities in the future.—***A. R. McIntyre***

## 25 INDIANA

Back at the Casa Grande Restaurant in Kokomo for our April 10th meeting we heard guest speaker, Mr. H. A. Meyrick, President of the Industrial Manufacturing Company, Indianapolis. Mr. Meyrick has pioneered the "Thermolator," a method of mold temperature control which represents a rather unusual departure from conventional water cooling. His control method was first tested extensively in Chicago about a year ago, and data obtained from these tests were presented at our meeting. Our last meeting until fall, held on May 15th at Linders' Restaurant in Anderson, heard Dr. George H. Found, Vice-president and General Manager of Saginaw Bay Industries. Dr. Found discussed "The Importance of the Independent Die Caster to the Automotive Industry." He reviewed the ways in which he believes the independent die casters will continue and even increase their contribution in today's market. At the 1958 Castings Congress and Exhibit in Cleveland, May 19-23, Harry Eriksen sat on the panel discussing Light Metals and Die Casting.—***Jim Poat***

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**REFERENCE BOOKS AND LITERATURE NEEDED—**

**In order to set up a National Headquarters Library for the SDCE, Sam Donebedian would be happy to accept all books, booklets and other technical references pertaining to Die Casting and its related arts. A few books have already been received. The Library will be strictly for the use of SDCE members. Send your contribution to SDCE Library, 19370 James Couzens Hwy., Detroit 35, Michigan.**

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I love a finished speaker,
I really, truly do.
I don't mean one who's polished
I just mean one who's through.

*—Richard Armour*

---

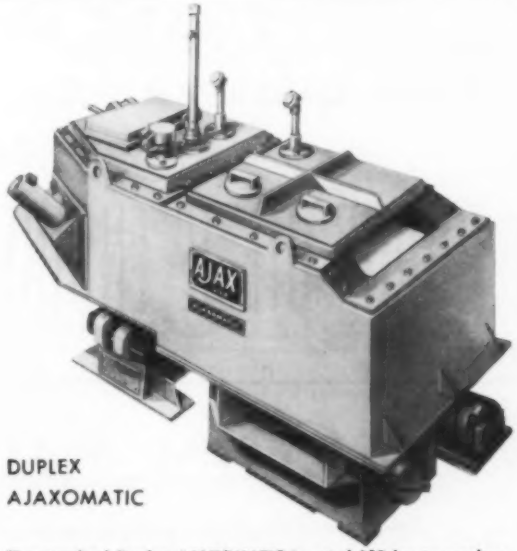
**AJAXOMATICS**

**bring automation to die casting**

The Duplex AJAXOMATIC melts aluminum pig and gates right at the die casting machine. By pushing a button the operator initiates the complete casting cycle: the die closes and the Duplex AJAXOMATIC pours the exact required amount of molten metal directly into the cold chamber. The operator just removes the finished casting at the end of the cycle.

Automation, however, is only part of the AJAXOMATIC story. The Duplex AJAXOMATIC also gives assurance of consistent quality. The quality of a finished casting begins with the proper melting of the metal. 60 cycle induction with its two basic features of internal heating and electromagnetic stirring is used exclusively in the Duplex AJAXOMATIC. Here are the unique characteristics of the Duplex AJAXOMATIC:

| | |
|---|---|
| Precision temperature control —at low temperature | No supply ladle system or hand ladles |
| Alloy uniformity —no segregation | Precise weight of automatic pour |
| No gas porosity | Comfortable working conditions |
| Low metal loss | Low maintenance |




DUPLEX
AJAXOMATIC

The standard Duplex AJAXOMATIC is rated 120 kw to produce 500 lbs per hour of castings ranging from ½ lb to 30 lbs. Other AJAXOMATICS are available to suit a wide range of production requirements, including units supplied from central melting systems. May we have an opportunity to study your requirements?

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60 CYCLE INDUCTION MELTING

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## PEOPLE IN DIE CASTING

**LEWIS A. CURTIS**, formerly Vice President in charge of Sales of the Package Machinery Company in East Longmeadow, Mass., has been elected President of the Company according to an announcement made by Roger L. Putnam, Chairman of the Board of Directors. Also announced were the elections of **Roger L. Putnam, Jr.** as Executive Vice-President and **J. Edwin Hanson** as Treasurer of the Company. Mr. Putnam, Jr. was formerly Vice-President in charge of Manufacturing and Mr. Hanson will continue as controller. The election of Mr. Curtis followed the resignation of **Donald H. Dalbeck** who had been President and Treasurer for the past two years.

In his early business life, Mr. Curtis was sales representative for the F. D. Palmer Company of Chicago, Illinois. This company was purchased by the Package Machinery Company in 1949. After the purchase of the Palmer Company, Mr. Curtis was located in the New York sales office of Package Machinery, becoming its branch manager in 1953. He was elected Vice-President and a Director of the Company in 1955.

TWO APPOINTMENTS to the Permanent Mold Die Company have been announced by John W. Wall, president. **Frank DeBuigne** now heads the company's activities in the special machine tool field. He was formerly with LaSalle Tool, Inc., and has specialized for many years in the design and development of automation machinery and equipment for the automotive industry. **Thomas E. Sheehan**, as factory sales representative, handles the sales of light alloy tooling for the automotive industry, specializing in die casting dies, permanent molds and casting equipment.

**MARVIN L. WALSH** has been appointed Assistant Advertising Manager of the Hoover Ball and Bearing Company, Ann Arbor, Michigan. R. W. Ebey, Advertising Manager, made the announcement and stated that in his new position, Mr. Walsh will be responsible for all of the company's collateral material. Prior to joining the Hoover organization, Mr. Walsh was the Assistant Advertising Manager of Aeroquip Corporation.

**WILLIAM ROSENQUEST** has joined the metal sales staff of The New Jersey Zinc Company. His headquarters will be in New York where he will sell the Company's slab zinc, zinc alloys, rolled zinc and metal powders.

**KENNETH W. DONLE** has been appointed Chief Engineer of the Tube Reducing Corporation, according to Edward H. Fisher, president. In his new post, Mr. Donle will direct all engineering activities at Tube Reducing, a manufacturer of cylinder-finish seamless steel tubing, compression-formed tubing and the "Niphos" process corrosion-resistant coating. A specialist in the metallurgical field, Mr. Donle joined the company in 1951 as chief metallurgist. He was successively named manager of Cold Draw Division in 1955, manager of product engineering in 1956, and manager of quality control earlier this year, the position he held until now. At present, Mr. Donle is the firm's representative on the Committee for Tubular Products of the American Iron and Steel Institute and a member of the American Society for Testing Materials. He received his degree in chemical engineering from the University of New Hampshire in 1939; he also studied at Carnegie Institute of Technology and the Illinois Institute of Technology.


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DIE CAST DIES STAMPING DIES
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JIGS FIXTURES

## PARTING LINE

(*Concluded from page 7*)

of the die cavity itself. This is not done in any other system . . .

In your last paragraph where you refer to the fact that systems that employ no hood do not encumber the die or limit the die caster, may I point out to you that I have actual time studies made after the Union has brought up grievances and then approval of the Union to show that the use of a hood does not limit the speed of operation of the machine. Therefore, it cannot be limiting the die caster, as far as operation . . .

The use of vacuum will permit the further expansion of die casting in the fields where it dares not touch at the present time . . . the possibility of making thin castings, good surface finish, will cut heavily into the stamping industry . . . our experiments here with running all types of aluminum alloys opens up the entire field of various alloys to be run which can only be run under vacuum since their fluidity is not high enough to run under the hand ladling system. This opens up the field for structural strength alloys for anodizing, etc . . .

Sincerely,
NELMOR MANUFACTURING CORPORATION
D. Morgenstern
President

**There seems to be a general disagreement over observed results obtained by using vacuum die casting. First, "Is injection pressure actually reduced in vacuum die casting?" and second, "What general system, at present, has the most advantages?" A meeting of the minds over these two questions would possibly reduce a great deal of the present confusion connected with the subject of vacuum die casting. —Ed.**


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Pre-tempered, ultra-sonic tested, tool steel for die casting dies. **ANY SIZE**

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Hot work die steels for die casting die inserts and extrusion tools. **ANY SIZE**

**"A-5 HOLDER BLOCK"**
Tool steel quality—Pre-tempered —Surface Ground top and bottom. **ANY SIZE**

**"CALDIE"**
Electric furnace alloy steel for plastic and metal die casting dies. **ANY SIZE**

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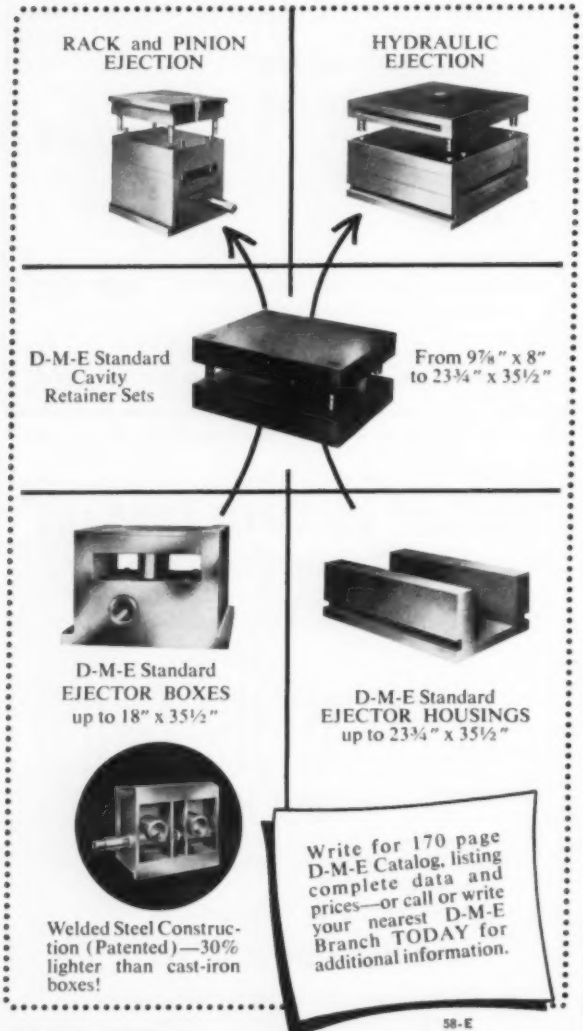
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# – NEWS of the INDUSTRY –

**THE B & T MACHINERY COMPANY** of Holland, Mich., manufacturers of a complete line of die casting machines for the zinc and aluminum die casting trade, announces the recent opening of a research laboratory for the investigation and testing of new developments for the die casting industry. In this laboratory, which is housed in a separate building containing 6,000 square feet of floor space and equipped with complete vacuum apparatus for the vacuum casting of both zinc and aluminum, many things, it is said, are going on for the benefit of the industry. Through development processes with prominent die casters, B & T Machinery Company is doing additional research work on efficient and economical methods of producing zinc and aluminum vacuum die castings in ranges from 25 inches to 28 inches of mercury with simple units that can be attached to most all makes of die casting machines. Studies are being carried out on an automatic zinc die casting machine. Coupled with this program will be development work on die temperature control units, automatic spray lubrication, automatic casting ejection, preladling and automatic ladling of aluminum. Included in the lab's equipment will be the new B & T air-hydraulic trim press. Requests for further details concerning information to be had and use of the laboratory, say B & T officials, are invited.

---

Two aluminum electrodes for flat and vertical welding (DC reverse only) on cast, drawn and sheet aluminum are announced by **ALL-STATE WELDING ALLOYS CO., INC.**, 249-55 Ferris Ave., White Plains, N. Y. One designated E-43 is for work wherever 5% silicon aluminum—Type 4043—is used. Other, E-2, is for pure aluminum, Type 1100. Availability of these electrodes will simplify aluminum fabrication and repair where inert-arc is not available . . . will enable many small shops and maintenance crews to get more out of welding machines they already own. Moisture bug-a-boo has been licked and shelf life extended by special compounding of the flux coating and by packaging in sealed plastic bags. Standard 50 lb. packaging provides 10 issues of electrodes that will remain factory fresh.

---

As a result of appointing more than 300 industrial distributors during the past year, **NYLOK-DETROIT CORP.**, Birmingham, Mich. announces that orders can now be placed locally in most areas for processing by the patented Nylok method, any quantity of socket, cap or set screws, or other commercially available threaded fasteners. The method involves inserting a Nylon pellet near the end of the threads —which permits such parts to form a completely adjustable, self-locking air and liquid-tight seal in use, without washers, O-rings, etc. Operating on an "open-line" basis, the Nylok-Detroit distributors can accept local orders for such processing of both stock and non-stock items—with prompt quotations and good deliveries.

---

**THE DOW CHEMICAL COMPANY** announces a one cent a pound price reduction to 0.1275 per pound in tank car quantities, freight allowed, effective immediately, on Chlorothene, Dow 1, 1, 1-trichloroethane, a solvent. Distinct safety advantages make this solvent ideal for many uses. It is one of the safest solvents available from the standpoint of low toxicity and low fire hazard. Used widely for many general metal cleaning applications, Chlorothene also finds use as a vapor pressure depressant in aerosols, as a spot remover, an adhesive solvent, a lubricant carrier, and an ingredient in cutting oils.

As part of a general expansion program aimed at providing a more complete service and broader, more comprehensive product development for the metal finishing industry, **ALLIED RESEARCH PRODUCTS, INC.**, of Baltimore and **WAGNER BROTHERS, INC.**, of Detroit have merged their operations. This move was accomplished by Allied's acquiring the metal finishing operational assets and products of Wagner Brothers. Included in the transaction was the sale of some of Allied's common stock to Wagner Brothers, Inc. Wagner Brothers, Inc. is now divorced from the metal finishing field but will continue to operate its subsidiary, Automatic Molding Machine Co., Inc. In jointly announcing the merged operations, H. C. Irvin, President of Allied Research, and J. R. Wagner, President of Wagner Brothers, Inc., and now Administrative Assistant to Mr. Irvin, emphasized that the key personnel of both companies will continue in the same general functions to assure uninterrupted and improved service on all products. Allied's headquarters operations are in Baltimore at 4004 East Monument Street while branch administrative offices have been established at 400 Midland Avenue, Detroit.

---

**NEWTON INSERT CO.** of Los Angeles announces the production of *Keen*sert, a new easily installed, self-locking threaded insert. It is designed to provide a strong internal thread for bolt attachment in relatively soft materials, such as aluminum and magnesium alloys and plastics. It may also be installed in the harder metals to provide a self-locking internal thread in a blind hole. *Keen*serts are supplied as one-piece, all-metal units, so that they are easy to handle at installation without fumbling for small accessory parts. They may be screwed by hand into tapped holes prepared with standard drills and taps. *Keen*serts are externally threaded along their entire length to provide maximum pull-out resistance. Positive mechanical resistance to rotation is provided by the *Keen*sert Kees, which are tightly fastened in the *Keen*sert and are easily pressed into the base material with a small punch and hammer or a simple installation tool. Newton Insert Co. also produces SPEED-SERT, the new self-tapping insert which eliminates the separate tapping operation common to most insert installations. Four extra sharp cutting edges enable the SPEED-SERT to cut its own thread as it is rotated into a cored or drilled hole, using a simple installation tool which fits into a standard tapping head. The unique design of the cutting edges provides adequate chip flow and prevents chips from entering into the internal thread.

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***Di-Metal die-casting alloys, their properties and their industrial applications, are described in a new 32-page booklet just published by the Federated Metals Division of American Smelting and Refining Company, 120 Broadway, New York 5, N.Y. Di-Metal is the brand name of a series of alloys, based on special high grade zinc, which are specially designed for economical die casting.***


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*This section is open to everyone associated with the arts and sciences of Die Casting. The editorial staff reserves the right to reject any advertising not related to Die Casting and its allied arts.*

*As a service to the Die Casting Industry, we offer space at a minimum of $10.00 for the first column inch and $10.00 for each additional column inch or any part thereof, payable in advance.*

*To answer box number advertisements, address responses to the box at Die Casting Engineer, 19370 James Couzens Highway, Detroit 35, Mich.*

*Closing Date: 15th of Month preceding publication.*

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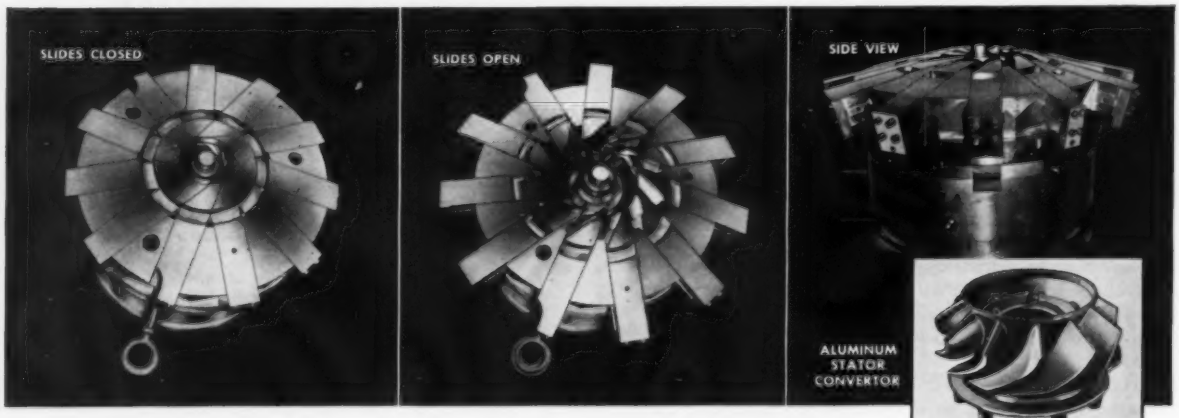


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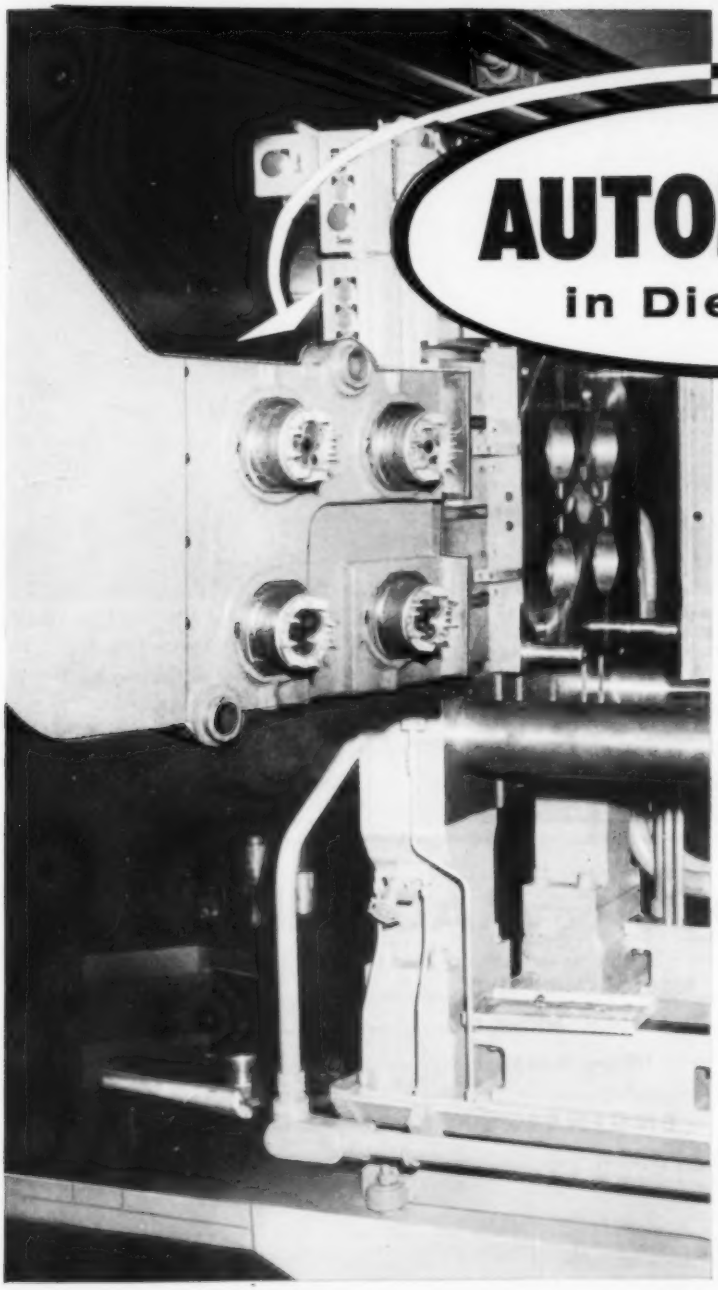

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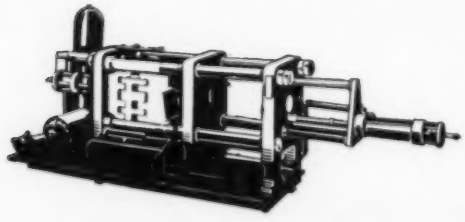

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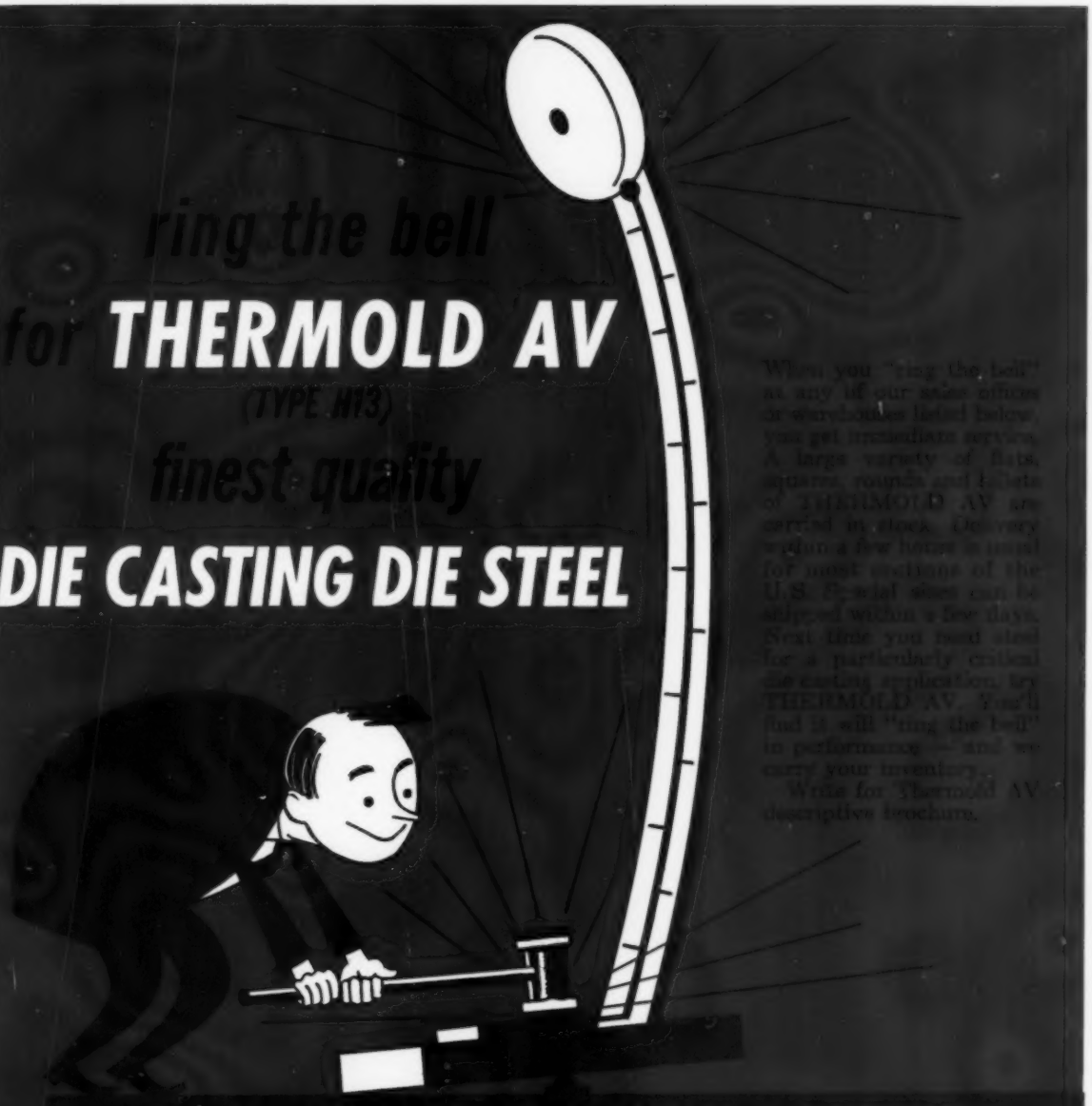

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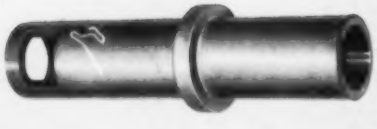

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